

VI. *Some Notes on Butterfly Migrations in British Guiana.*
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WITH SKETCH MAP.

[Read March 7th, 1917.]

THE whole problem of the migration of insects, and of butterflies in particular, is one of great interest, and, at the same time, one about which we have so little data that it is almost impossible at present to make any generalisations. With the exception of records of such well-known migratory insects as the locusts, most of the published accounts are fragmentary, inaccessible or isolated records for a country by passing visitors. From the records relating to butterflies almost the only common fact which emerges is that migrations are particularly abundant in the *Pieridae*, records in this group being known from all parts of the world.

I have recently spent a few months in British Guiana, and have been fortunate enough to observe two migrations of the yellow Pierid, *Callidryas eubule*, one of which lasted for at least ten days. I also questioned a number of residents of the district about migrations, which when large are noticeable even by the non-entomological public, and find that they are a phenomenon of regular occurrence, and that almost every one who has resided there for any length of time has seen the clouds "of yellow butterflies all flying steadily in one direction." Most of the accounts were too vague to be of any value, especially with regard to details; but from among them I was able to get some in which the locality and the direction of flight was given with sufficient appearance of accuracy to make it seem worth recording. In addition to these I have given extracts from a few published accounts of migrations in British Guiana, chiefly from local publications which are not readily accessible to the entomologist.

The climatic conditions near the coast of British Guiana, to which district most of the records refer, consist of two wet and two dry seasons each year. In general, February

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to April is more or less dry; May to the middle of August wet; the end of August to October the driest season; and November to February again wet. Further in the interior the second dry season is lost, and there is only one wet and one dry season each year.

There are given below particulars of sixteen different migrations (really more, as some of the records refer to a number of similar migrations seen in the same locality in different years). All except one of these refer to *Callidryas eubule*. Two are from my own observations, nine are collected from residents and are, I believe, quite reliable, while five have been previously recorded. The exact locality and direction of all, except one, will be found indicated on the accompanying map.

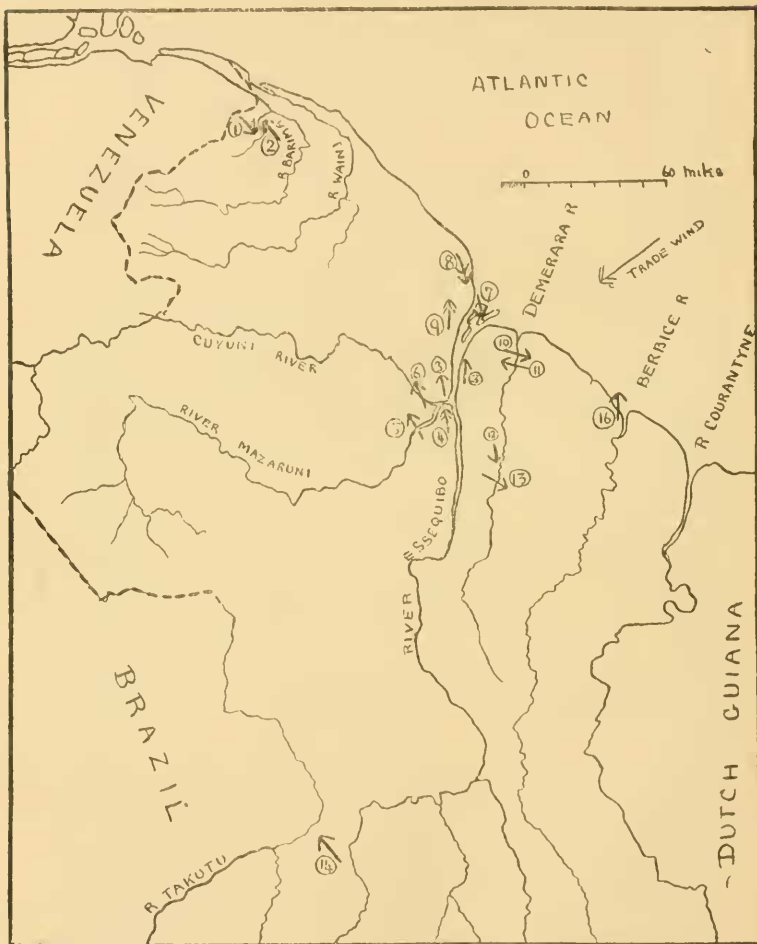
1. This migration I saw in the North-west District of British Guiana within a short distance of the Venezuelan border. Most of the observations were made on the River Aruka, between the junction with the Barima, of which it is a tributary, and Issororo about six miles further up the Aruka. The junction of the two rivers is about twelve miles in a direct line to the coast, and about nine miles from Venezuela. The district is chiefly a vast forest swamp, below the high-tide sea level, with here and there a small rounded or flat-topped hill, one or two hundred feet high.

The migration consisted almost entirely of the yellow Pierid *Callidryas eubule*, interspersed with a very small proportion of at least three other species which I was unable to catch; one of them, a large, dark, Papilio-like insect, may possibly have been *Cydimon* [*Urania*] *leilus*, a day-flying moth which is not uncommon in the district, and which has been recorded as having migrations of its own.

I first became aware of the migration on August 1st, 1916, although three days before specimens had been noticed in the district. It was then two and a half months after the beginning of the first wet season. The migration was only at times really conspicuous and never attained a density which could without exaggeration be recorded as a "thick cloud." On many days only careful observation indicated that anything unusual was occurring. In order to get a comparative idea of the density of the migration a distance of about two hundred yards was estimated from the observer in a line across the direction of flight (in close spaces this sometimes had to be reduced

to one hundred yards or less), and the number of butterflies crossing this line per minute was counted.

It will be best to give the actual observations taken at the time.



1st August.—The yellow butterfly, *Callidryas eubule*, was migrating in large numbers to-day. They were flying in an easterly to south-easterly direction almost across what is, for this district, a rather strong wind. They were first

noticed crossing the River Aruka about half a mile from Issororo. At 1.10 p.m. I counted in a little over five minutes sixty-two *Callidryas*, one orange butterfly of about the same size, one smaller yellow species, and two dark Papilio-like insects crossing a space estimated at two hundred yards (moving as our boat moved). They became rapidly more common, and from 1.30–1.35 I counted three hundred and fifty crossing the same estimated distance. They were then for some distance a little less common, but at the junction of the Aruka and the Barima, where we arrived at about 2.15, at least a hundred and fifty per minute were passing. Below this the flight thinned out, and at Morawhanna, four miles below the junction, scarcely any were to be seen. The course of the rivers is far from straight, but the flight must have been at least five miles across. About one in a hundred of the butterflies was a bright orange species, and a smaller proportion of the dark Papilio-like species; this latter may, however, have been more common, as it was difficult to see at a distance.

Catching butterflies while standing up in a small boat is neither easy nor safe, but I managed to net two specimens, one male and one female.

2nd August.—We left Morawhanna at 11.30 a.m., and were in the migration practically the whole way back to Issororo, where we arrived at 2.30 p.m. The butterflies were occasional near Morawhanna, almost as common as yesterday at the junction of the Aruka and Barima, and frequent all the way up until near the end, when a very heavy shower sent both us and them into shelter. Even in the thinner parts ten to twenty per minute were crossing every two hundred yards. To-day I caught five specimens, four males and one female.

3rd August.—At ten o'clock this morning the yellow butterflies were flying at the rate of two or three per minute past the house (in a clearing about one hundred yards wide and about half-way up a hill about two hundred feet high). At 10.15 none were to be seen; at eleven o'clock they were again noticed for about five minutes; at 12.30 they were still passing over three or four per minute, and again at two o'clock they were seen occasionally in intervals between showers. At 3 p.m. a few more were noticed. I caught to-day one more specimen, a female.

4th August.—At 9.30 a.m. six or seven *Callidryas* were seen passing south-east over the house; about 11 a.m. they

were noticed whenever the sun was shining; between 11.35 and 11.40 thirty-four passed over on a hundred yards line. At 1 p.m. two or three per minute were flying rapidly at the foot of the hill, all going south-east. At 2 p.m. they were still passing, but none were seen after three o'clock. One caught to-day was a male.

5th August.—Very wet, 1.38 inches of rain; no butterflies seen.

6th August.—They were first noticed to-day at 11 a.m.; from 11.30–11.35 sixty-three passed over the garden, *i. e.* thirteen per minute on a hundred yards line.

7th August.—The butterflies are still migrating. At 9.30 a.m. six or seven per minute were passing the house; at 10.15 a.m. eight a minute were passing on a hundred yards of garden; and again at mid-day and at one o'clock they were still flying. One specimen captured to-day was a male.

8th August.—At 11.15 a.m. they were again noticed migrating. The sun seems to make a great difference to the flight. I started counting at 11.16 a.m., and in the first minute eight passed; then the sun went in, and in the next four minutes only three were seen; in the first two minutes of sunshine after this fifteen passed. Do they follow the patches of sunlight, or settle when a shadow comes? The former does not seem possible, as they have always been flying across the direction of the wind. At 1.15 occasional specimens were seen crossing the river, but they were far apart; at a casual glance it might not be noticed, but every ten seconds or so one would come into view going full speed south-east.

9th August.—The butterflies were still in migration, but only occasionally in intervals between heavy showers.

10th August.—The butterflies were plentiful to-day, crossing the river at Issororo at least twenty to thirty per minute on two hundred yards line. Half a mile between Issororo they thinned out and remained at three or four per minute right down to the river junction; below this to Morawhanna only very few were seen. I made an attempt to-day to estimate the speed at which they were flying; previously I had found it impossible to overtake them even when on a clear footpath, and had considered their speed as at the very least nine miles per hour. The river now gave a good opportunity of testing this, as they were passing directly across it and could be timed from

one side to the other with ease. The river was at least a hundred and fifty, and possibly two hundred yards wide. Three butterflies were timed and took twenty, twenty-four and twenty-six seconds to cross. Taking twenty-four seconds as an average and a hundred and fifty yards as the distance, this gives twelve miles per hour (if the river were two hundred yards wide it would be sixteen miles per hour). This is, I think, a not unreasonable estimate.

In flying the insects kept close to the surface over which they were passing; over the forest they seemed never to be more than a few feet above the tops of the trees, and in any but the smallest clearing they descended rapidly to the ground and flew between small bushes and trees about four to eight feet up. On crossing the river they kept still lower, being seldom more than three feet above the water and occasionally almost touching it.

Any attempt to estimate the number of butterflies in a flight of this kind must of necessity be only an approximation. Taking ten butterflies per minute per two hundred yards as an average, this gives 5,400 per hour per mile, or 135,000 for a day of five hours on a front of five miles. At the rate noted at the junction of the Aruka and Barima on the 1st August (150 per minute) 84,000 would pass in a single hour on a front of one mile.

On the 10th August I left the district, and was later informed by Mr. A. A. Abraham, Manager of the Government Experimental station at Issororo, that the butterflies disappeared shortly after my departure.

The chief points of the above migration may be summarised as follows: (1) The migration lasted at least ten days; (2) both males and females were represented, the former predominating (my total captures were seven males and three females). (3) They flew constantly in a south-easterly direction at a speed of about twelve miles per hour across the prevailing north-east trade wind.

2. In the middle of October 1916 Mr. Abraham wrote to me from Issororo to say, "Since my last note to you [end of September] I have observed that the butterflies are returning at the same rate and numbers to the bank of the river from which they migrated." This is a particularly interesting record, as it confirms several other records of migration in opposite directions in the same locality about which I had been doubtful.

3. In September 1916 I observed a very diffuse migra-

tion at Bartica at the junction of the Essequibo, Cuyuni and Mazaruni Rivers, and from there down towards the mouth of the Essequibo. On the 11th September I noticed that all the *Callidryas* passing over the garden of the house where I was staying (at H. M. Penal Settlement on the opposite bank of the Mazaruni to Bartica) were flying in the same direction, towards the N.N.W., at full speed. They were not common, and in twenty minutes (12.40-1 p.m.) I only counted thirty-nine, *i. e.* about two a minute; during that time not a single one was seen to settle, or fly in any other direction. They were still passing over about half an hour later, but after that the usual afternoon rains came on and they were not seen again that day. There was a slight east wind blowing at the time. On the following day (12th September) at Bartica, several were seen, again all flying full speed N.N.W. On the 13th September I descended the Essequibo to the mouth by steamer, and during the early part of the journey *Callidryas* were flying N.N.W. at the rate of four or five a minute on a two hundred yards line. There was then practically no wind. About 10.30 a.m. the north-east trade wind became stronger, and the flight changed to a westerly direction (almost directly across the river instead of down it). This would be the natural resultant of a N.E. breeze on an attempted flight in a N. or N.N.W. direction.

4. Mr. Withers, Manager of Hills Estate, Bartica, who has resided in the district about seven years, tells me that he has many times seen the yellow butterfly migrating, sometimes for days together, *always in a N. to N.W. direction*. These flights, he says, usually occur in October.

5. Mr. Frear, Chief of H. M. Penal Settlement, tells me that about the beginning of August 1916 there was a small flight about ten miles up the Mazaruni River flying north-west. This would be about the same time as I saw them at Issororo, flying in an exactly opposite direction.

6. Mr. Cameron, Acting Chief Engineer of the Government Steamer Service, tells me that on the 8th September, 1916, he saw a small number of yellow butterflies at Camaria on the River Cuyuni, about eight miles above the Penal Settlement, all flying north-west.

7. H. W. B. Moore, in "Timehri," the Journal of the Royal Agricultural and Commercial Society of British Guiana, 3rd Series, vol. ii (1912), p. 405, says: "In July . . . I observed thousands of *Callidryas eubule* . . .

flying across the Essequibo River from Wakenaam to Hog Island and Great Trolley Island [all near the mouth of the river]. They were flying chiefly in ones, but twos and threes and higher numbers were not infrequent, whilst once in a way a flock of twelve to twenty could be counted. The great majority were males. . . . Soon after Kurubaru Islands were passed the butterflies were seen to be flying from the mainland towards Wakenaam. Going on towards Aurora and Suddie on the west bank at the mouth of the river they were seen flying upstream, following, it seemed, the direction of the wind." All the directions mentioned are between south and east.

8. Mr. Marshall, who was for many years Manager of a sugar plantation near Suddie, on the west bank of the mouth of the Essequibo, tells me that migrations of the yellow butterfly are a regular phenomenon there, chiefly in May and June, rarely July, always flying from the N.W. towards the S.E., which is across the prevailing N.E. wind. They come from the north-west, and frequently reach the coast just north of the Suddie; there they turn southward along the coast to the mouth of the Essequibo and then cross over *via* Tiger Island, Wakenaam, Leguan, etc. It must have been one of these migrations which Moore describes above (7).

9. Mr. Humphreys, for many years Manager of a sugar plantation at Anna Regina, which is not far from Suddie, says that he has frequently seen migrations going in a northerly direction down the Essequibo River and up the Coast. This is in the exact opposite direction to the last recorder, but there is, I think, no reason to doubt that both are possible. Mr. Humphreys made the further interesting remark that the butterflies were sometimes in a long, narrow band, only ten to twenty feet wide.

10. Mr. Rodway, in "Timehri" (see above), 3rd Series, vol. i (1911), p. 131, says: "*Callidryas eubule* . . . is noted for its extensive flights; for hours they have been seen passing over the Demerara River going east, probably billions in number, and all males. Whence they come and whither they go is a mystery. Their food-plants [*Cassia*] are common everywhere, and there does not appear to be any scarcity of females." He refers again to this migration in "In the Guiana Forest," 2nd edition, 1911, p. 122, but with no further particulars.

11. Mr. Peterkin, of the Department of Agriculture,
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tells me that about 1906 he saw a migration of some thousands of yellow butterflies crossing the Demerara River from Plantation Diamond to Plantation Wales, that is, from the east to the west bank about six miles from the mouth of the river. They were flying with a strong wind behind them.

12. The Rev. Mr. Salmon tells me that at Wismar (about sixty miles up the Demerara River) at the beginning of August 1916 he saw a "procession" of yellow butterflies between his house and the river. They were flying in groups of ten to twenty, with a short interval between each group. The flight was first noticed at mid-day and lasted for several hours after this. It might have already been proceeding for some time. They were flying approximately from N.N.W. to S.S.E.

13. Messrs. Bancroft and Ward described to me a migration that they had seen a few days before, about the 20th September, 1916, at Murirato, about ten miles above Wismar on the Demerara River. The butterflies were all flying from the left to the right bank of the river, that is, from west to east.

14. Richard Schomburgk, in "Reisen in Britisch Guiana," Zweite Theil, Leipzig, 1848, p. 157, describes a migration of yellow butterflies which flew from S.E. to N.W. in the interior of British Guiana near Pirara about the 13th September, 1842. The flight lasted the whole day, and at mid-day and just before sunset the butterflies settled in countless numbers on the patches of sand at the edge of the river. According to the natives they were the butterflies which came from certain caterpillars and chrysalides which they readily ate.

15. Both Moore (*l.c.*) and Rodway ("In the Guiana Forest," 2nd edition, p. 122) refer to a record of a migration by Robert (not Richard) Schomburgk, of which, however, I have been unable to trace the original. Moore says it was observed by Sir Robert Schomburgk "on the 18th of October, 1838, when going up the Essequibo, and it continued crossing the course of the river for nine hours and a half, during which time his boat ascended nine miles. A thousand million is not too high an estimate for the number of individuals in the swarm."

16. This last record relates not to *Callidryas eubule*, but to another Pierid, *Appias margarita*, a small white species. Mr. A. Leechman, in the "British Guiana Handbook,"

1913, p. 137, writes that he has "once witnessed a flight of white butterflies (*Appias margarita*) on the lower left bank of the Berbice River which lasted for over three days, and could only be compared during the whole of that time to a heavy snowstorm. And the extraordinary thing was that they were all flying directly out to sea. Mr. Leechman has informed me that this occurred in April 1909.

It is difficult even from the above records to get any indication of what is happening. On the real problem, why the migration takes place, there is still no light, and many more correlated observations must be made before there can be any hope of solving it.* There are, however, a few points to which attention might be directed. In the first place, there are here two general directions of migration for *Callidryas eubule*, roughly from the north-west to the south-east, and *vice versa*. There is as yet no record of a migration in a north-east or south-westerly direction. The prevailing wind is the north-east trade wind, so that the migrations were across the wind. It is impossible to say if this is the real determining factor in the direction of the migration or not.

Secondly, all the migrations of *Callidryas* in which the date is recorded took place between May and October.

Thirdly, it seems possible to distinguish between several different types of migration. At least one can make a rough but convenient grouping into three classes. (1) The thick cloud, "like a snowstorm," a case which immediately attracts the attention of the ordinary individual and is most frequently recorded. (2) The diffuse migration, which may vary from distinctly noticeable to so attenuated that only a close observer would realise that anything unusual was happening. There is, of course, no strict line of demarcation between this and the last, and the edge of a "cloud" migration would probably be diffuse. A diffuse migration, however, can exist unaccompanied by a cloud. (3) A particularly interesting form is the "ribbon" migration, or "procession," in which a narrow band of butterflies a few feet or a few yards wide flies across the country in the direction of its length. The edge of such a migration is well defined. In this connection it might be mentioned that, even when not on migration,

* British Guiana would seem to be a promising field for such investigations, but they must be extended over a series of years, with a number of competent observers stationed over the country.

Callidryas eubule has a habit of flying round and round a field in short strings of about half a dozen almost head to tail, and closely following each other's movements. This habit may throw some light on the formation of the ribbon, but does not explain the movements of the leader.

Finally, we have the extremely interesting question of the sexes represented in the migration. Rodway records that all that he saw were males, but I understand that this was from observing their colour whilst in flight. The male and female of *Callidryas eubule* differ distinctly in colour and markings, and perhaps any one very familiar with this species could tell them apart in this way. I found it impossible to do so, and could only tell the sex after capture. My specimens were, as mentioned before, seven males and three females. It does seem, then, to be a general rule that the males predominate, and this is confirmed by observations in other parts of the world. This branch of the subject seems to me to be of fundamental importance, for if the migrations consist so largely of males, what becomes of the corresponding females? Mr. Rodway has bred this species and finds the two sexes to be more or less in equal numbers, and this is the general rule for other insects except in rare cases, such as parthenogenetic reproduction, which seems scarcely feasible here. There remains the possibility of the males developing more rapidly and emerging from the chrysalides earlier than the females, but there is no direct evidence for this, and against it is the fact that, except perhaps at the beginning of the first wet season, the successive broods of insects in the tropics are ill-defined and usually overlap considerably. It may be contended that the females are less fitted for long flights, being heavily laden with eggs. Even if this is so, we are left with the question, "Why, then, do the males migrate?"